CHAPTER 5

AIRCRAFT FIREFIGHTING AND RESCUE

Section I. INTRODUCTION

5-1. Purpose

This chapter provides Army firefighters with the correct procedures for rescuing personnel from burning aircraft and for fighting aircraft fires. Preservation of life and prevention of injury should be the first objective of all firefighters; the saving of aircraft is secondary.

5-2. scope

Various phases of aircraft firefighting and rescue are covered herein. Section I includes general information on the characteristics of fire as they pertain to aircraft and aircraft materials. Section II familiarizes firefighters with the specific components of aircraft and the fire hazards associated with them. Section III describes emergency procedures, and gives illustrations of the general arrangement and the emergency procedures for typical Army aircraft.

5-3. Flammable Materials in Aircraft

a. Flammable materials and fire-accelerating materials carried in each aircraft are of major concern to the firefighter. The materials may include a combination of the following:

(1) Gasoline, turbine engine lubricating oil, and jet fuel.

(2) Oxygen.

(3) Oils.

(4) Hydraulic fluid.

(5) Anti-icing fluid.

(6) Grease.

(7) Pyrotechnics, ammunition, and other ordnance.

b. Of the above materials, gasoline and jet fuel are the greatest problem in firefighting. The crash firefighter must remember that danger of fire or explosion is always present in the aircraft fuel system.

5-4. Fire Hazards of Aviation Gasoline, Turbine Engine lubricating Oil, and Jet Fuel

A knowledge of the characteristics of gasoline, turbine engine lubricating oil, and jet fuel is essential to the aircraft firefighter. See paragraph 4-3*b* for extinguishing class B fires.

a. ***Gasoline* and *Turbine Engine Lubricating Oil.***

(1) ***Aviation gasoline versus automotive gasoline.*** Aviation grades of high-octane gasoline, with octane ratings of about 115 to 145, are not greater fire hazards than automotive grades with a rating of approximately 90. Actually, automotive grades have a slightly higher volatility. However, for practical considerations, gasoline of any octane rating within the automotive or aviation range (approximately 70 to 145) presents identical fire extinguishing problems.

(2) ***Turbine engine lubricating oil and aviation gasoline grades and uses.***

(*a*) Whole, unheated turbine engine lubricating oil, Military Specification ML-L-7808, is relatively nontoxic and does not present a serious health problem. Some dermatitis can be expected in unprotected personnel continuously exposed to whole unheated oil. However, the decomposition products resulting from temperatures above 500° F. (260° C.) are toxic. Adequate ventilation should be maintained where these oils are heated above the critical temperature.

(b) Aviation gasoline consists of hydrocarbons except for the addition of chemical agents, such as tetraethyl lead, inhibitors, and dye. The various grades are dyed distinguishing colors of red, blue, green, and purple for identification purposes. Aviation gasoline is provided in four grades and colors, in accordance with Military Specification MIL-F-5572, as follows:

1. Grade 80/87, for use in light aircraft and helicopter engines, red if it contains tetraethyl lead, otherwise dye free.

2 Grade 91/96, for use in light aircraft and helicopter engines, blue.

3 Grade 100/130, for use in high output aircraft engines, green.

4 Grade 115/145, purple in color, is the standard grade of aviation gasoline used in all Army aircraft gasoline engines (app. II).

b. Jet Fuel. Jet fuel is designated JP-4 (Military Specification MIL-F-5524) and is used in the gas turbine series engines installed in some Army aircraft. This type of fuel must be handled with as much caution as gasoline. Jet fuel mist in air ignites readily regardless of the theoretical advantages of a kerosene grade fuel.

Section II. AIRCRAFT FIRE HAZARDS

5-5. What Firefighters and Operation Personnel Should Know About Aircraft

a. Firefighters and operation personnel must be familiar with the fire hazards of every aircraft that uses the nearby airfields. After an aircraft is on fire, it is too late to make a study of it to determine the best methods of lifesaving and firefighting. An aircraft fire requires immediate, intelligent, and carefully planned action. Every situation is different, but often the rescue squad has only a minute to rescue occupants from a burning aircraft.

b. A knowledge of the location, function, and operation of all parts of an aircraft is necessary, whether they appear to be fire hazards or not. Nearly any part of an aircraft may become important to firefighting, often under unanticipated circumstances. For example, a landing gear strut would not ordinarily be considered worthy of study from a firefighting point of view, but when it is known that on a certain type of aircraft the strut has been driven upward and has ruptured a fuel tank, it is evident that a knowledge of its position and action is important. A crucial decision on firefighting or rescue operations must often be made within seconds.

c. Features of aircraft which are directly connected with fire hazards and rescue are outlined in generalized form in the following paragraphs. These may be applied to the study and investigation of any specific type or individual aircraft. Such studies must be supplemented by personal inspection of the aircraft, contact with flight and maintenance personnel, and review of current aviation magazines and manufacturer's data. The best way to learn about aircraft is by inspecting and asking questions about them. Few aircraft, even of the same type, are identical in every respect. Some aircraft of the same type are altered for performance of different tasks. Others are assembled in different ways, or changed for special reasons after being in service.

5-6. Aircraft Design

a. Modern Army utility aircraft are of all-metal construction. Figure 5-1 illustrates the general arrangement of transport aircraft.

b. Helicopters differ from fixed wing aircraft in that lift comes from rotor blades mechanically rotated about an approximately vertical axis. Figure 5-2 illustrates the principal structural units of a helicopter.

c. Helicopters may be broken down into two main types: the single rotor type and the tandem rotor type. The single rotor type uses a small antitorque tail rotor to overcome the effects of torque, while the tandem rotor type rotates the blades in opposite directions, thus reducing torque to an acceptable limit. The flight controls of a helicopter have primarily the same function as those of fixed-wing aircraft. The only additional control is the collective pitch stick, to the left of the pilot. A motorcycle-type throttle is attached to the end of the pitch stick.

5-7. Powerplants and Components

The engines are divided into two groups, the reciprocating engine and the gas turbine engine.

a. ***Reciprocating Engines.***

(1) The reciprocating engines are air-cooled and constructed on a radial or opposed design. Radial types are used in larger engines and present the greater fire hazards. On a radial type engine, the cylinders are installed in one or more separate rows around the crankshaft. The crankshaft of a helicopter extends into the clutch or transmission assembly and forward to the propeller installation, and far enough to the rear to drive auxiliary equipment such as generators, oil pumps and hydraulic pumps. A radial engine and accessory section are shown in figure 5-3. Figure 5-4 shows an opposed engine and accessory section.

(2) The fire hazard in the cylinder section of the engine is very small unless the cylinders frac-

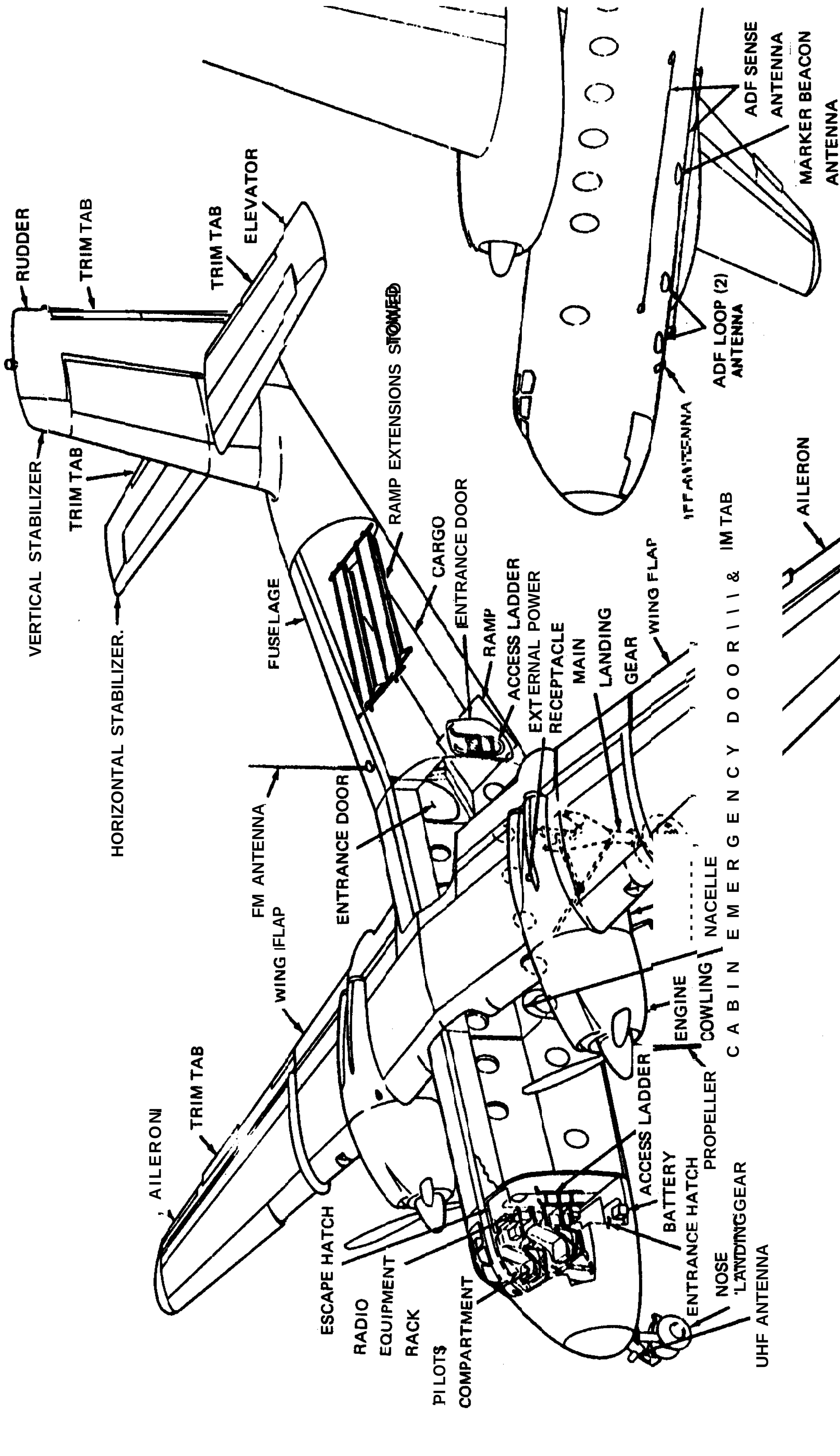


Figure 5-1. General arrangement of transport aircraft.

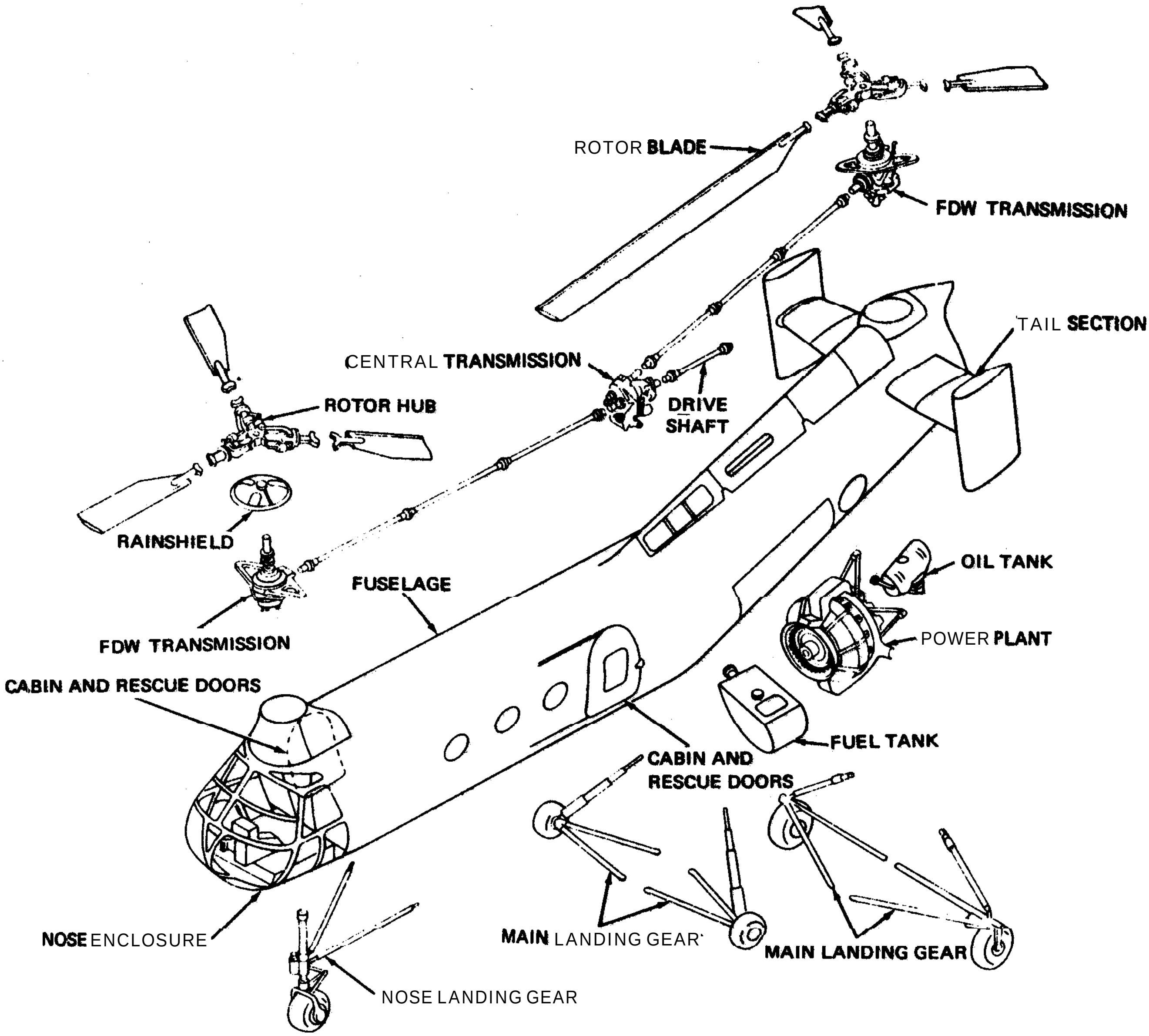


Figure 5-2. Principal structural units of a helicopter.

ture. The greatest fire hazard in the cylinder section are the electrical wiring, oil lines, and a small amount of tubing. An engine cylinder section seldom presents a fire problem.

(3) The accessory section is located immediately to the rear of the cylinder. The accessory section contains the carburetor, internal supercharger, main fuel lines, fuel pump, oil lines, oil pump, generator, magnetos, electrical connections, and other engine equipment. In some aircraft, the accessory section contains the oil tanks and storage batteries. The most serious engine fires occur in the accessory section.

(4) The accessory section is filled with equipment containing moving parts (figs. 5-3 and 5-4). Broken fuel and oil lines generally occur in the accessory section and are the source of fires both in the air and on the ground, either under normal conditions or in the event of a crash.

(5) Access to the accessory section is gained by removing the engine cowling. The cowling is fastened with dzus and other special rapid fasteners and can be quickly removed. The fasteners can be opened with a screwdriver which is part of the crash rescue tool kit (fig. 5-5) or a coin, since the exposed top is slotted for turning. Many instances occur where the intensity of the fire will prevent the removal of the cowling. It is then necessary to gain access to the accessory section by quick use of forcible entry equipment. The cowling is gener-

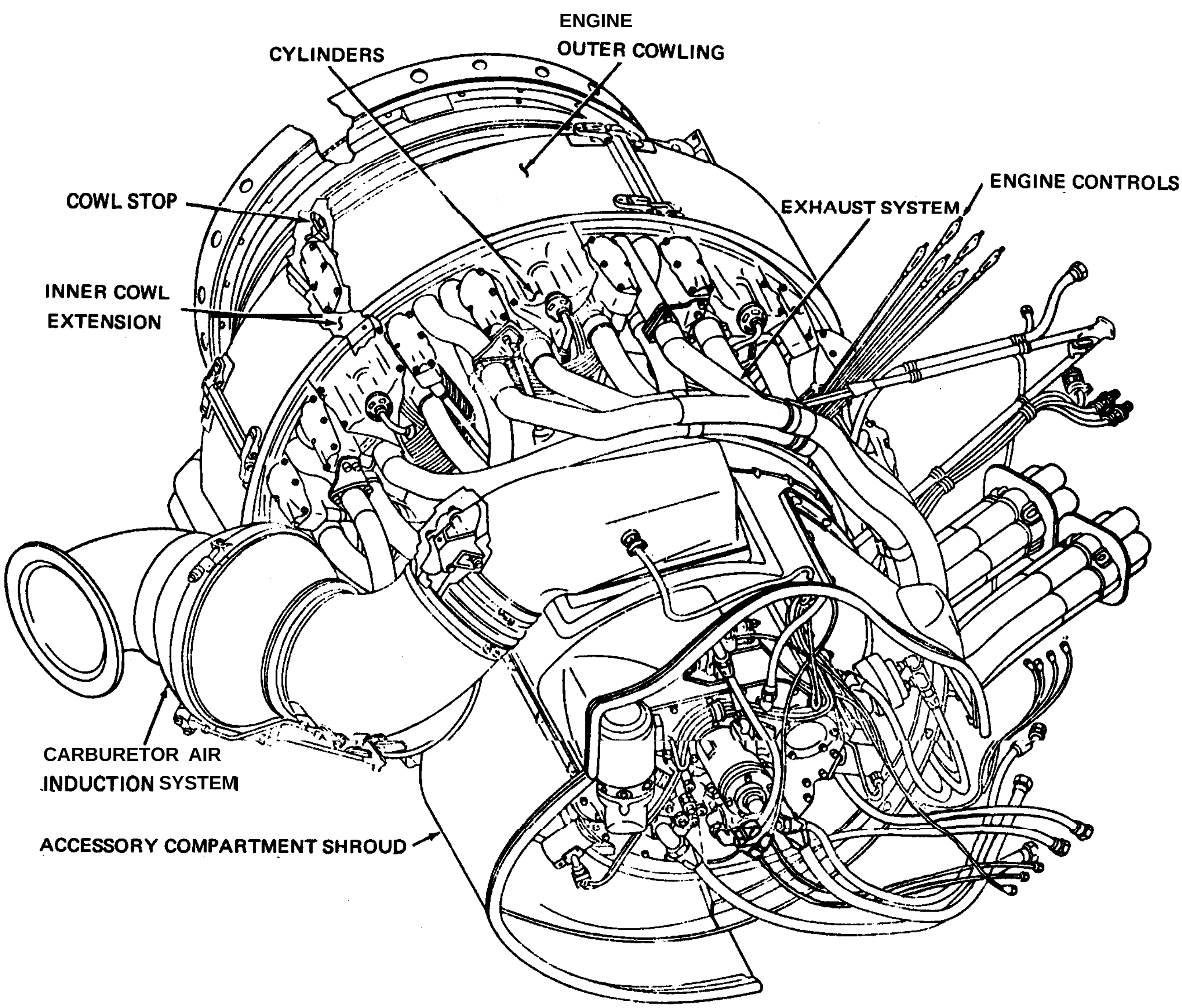


Figure **5-3.** ***Radial engine*** and accessory ***section.***

ally constructed of metal a little thicker than the aircraft skin, but can quickly be entered with crash kit tools. Effectiveness of the extinguishing agent within the,confined space may be increased by keeping the cowling in place and by using bayonet nozzles or applicator.

NOTE

If it is a severe engine fire, check accessory section first.

(6) There may be a forward firewall or shroud between the forward section of the engine containing the cylinders and the accessory section. On most aircraft, a main firewall is located between the accessory section of the engine and the adjoining portions of the aircraft. In single-engine aircraft, the main firewall is 'between the accessory section and the pilot's compartment. In multiengine aircraft, the main firewall is between the engine and the rear of the nacelle with its adjoining wing structure.

(7) Aircraft firewalls consist of a metal plate thicker than the aircraft skin. The firewalls are not thick enough to prevent the passage of heat for a long time or the actual transmission of fire from one section of the engine to another section or to the rear structures. Firewalls are pierced with necessary openings for cables, linkage, tubing, etc (fig. 5-4). In some instances, there is clear space between the device passing through the firewall and the opening. The objective of the firewall is to localize, for a brief time, a fire in the engine cylinders or accessory sections.

(8) It is important that firefighters know the

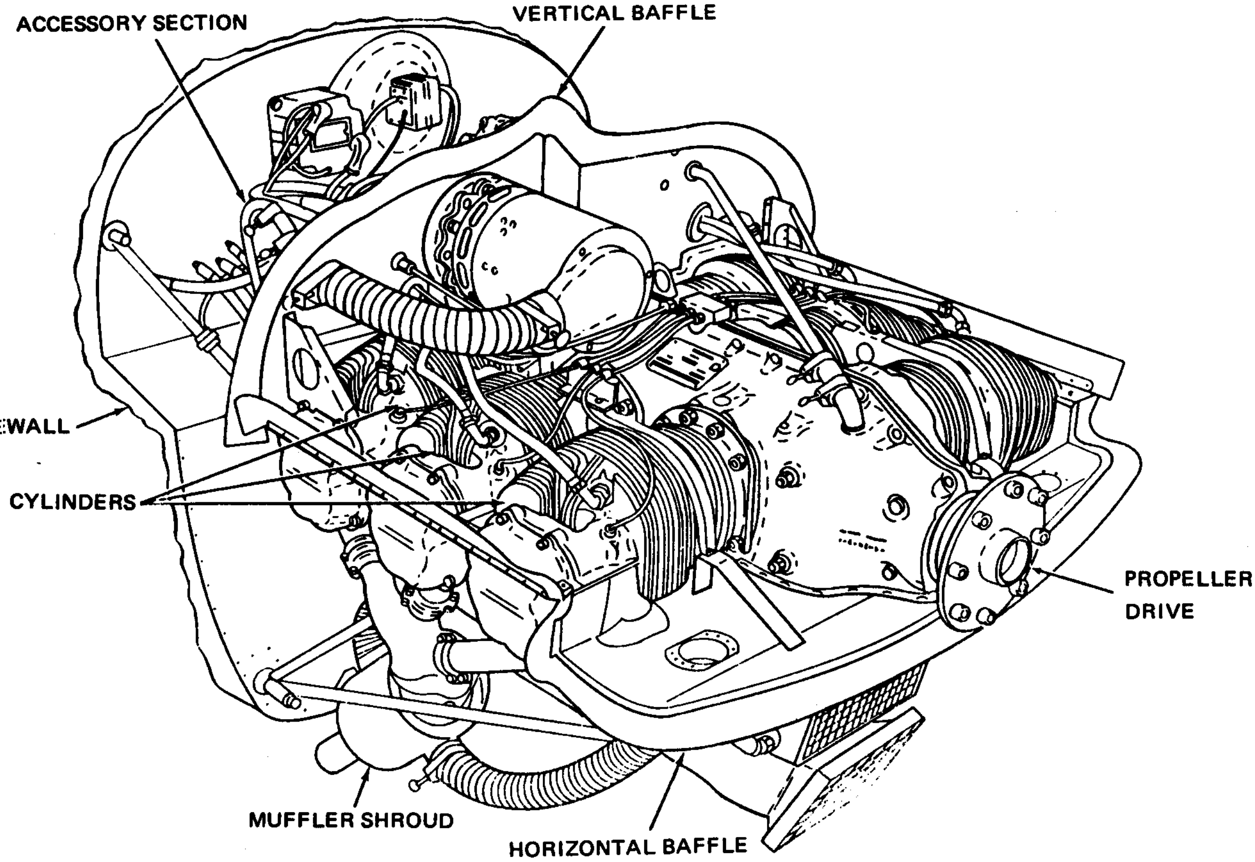


Figure 5-4. Opposed engine and accessory section.

location of firewalls and accessory section components. With the engine cowling removed, each type of engine should be studied from a firefighting point of view.

(9) On radial engines having only a single row of cylinders, baffler plates or shields are placed between the cylinders and the cowling. The shields are close-fitting and regulate the flow of air to the rear of the cylinders. The shields should not be confused with a firewall as they will do very little to localize a fire. Their purpose is to reduce the volume of air which can pass over the rear of the cylinder cooling fins. There is some fire hazard from the coil connections and ignition harness forward of these shields.

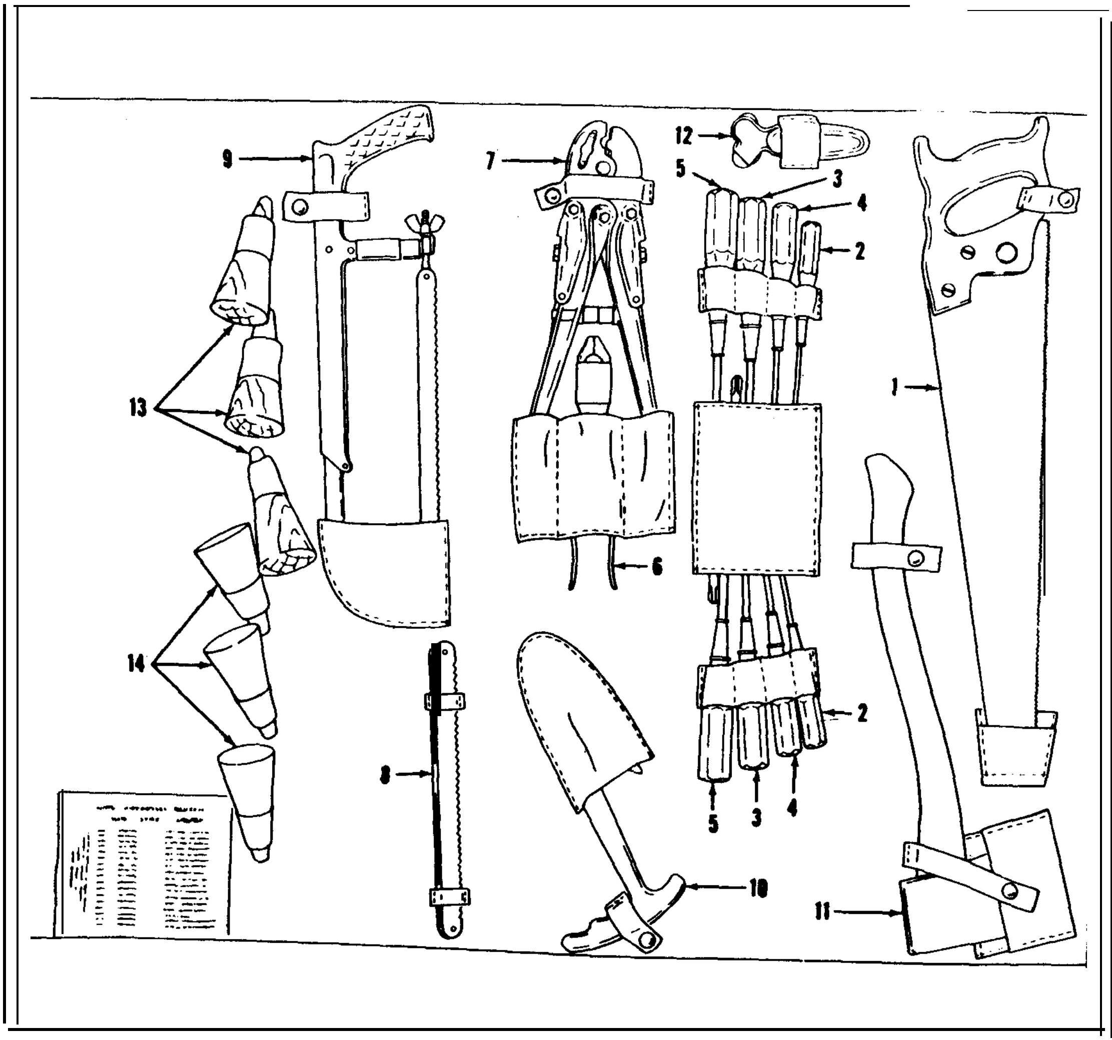
(10) On multiengine aircraft, the main firewall at the rear of the engine isolates engine fires 'to some extent from the remainder of the nacelle and from the wing structure. The rear of the engine nacelle may contain oil or hydraulic fluid tanks, a housing for retractable landing gear, or other equipment.

(11) Cowl flaps are installed near the firewall between the engine and accessory section. The cowl flaps are important to a firefighter because they provide immediate access to the engine without removal of sections of the cowl surface. A CO_2 horn applicator nozzle may be placed at, or thrust through, the opening at the cowl flaps to quickly combat engine fires.

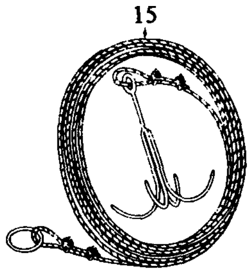
(12) When an engine is started or warmed up, a firefighter will stand to the rear of the propeller and be prepared to combat an engine fire through the cowl flaps. On emergency landings, the cowl flaps may be in the closed position. It may be faster to pry a flap loose with a small bar than a hole could be penetrated or a section of cowling removed.

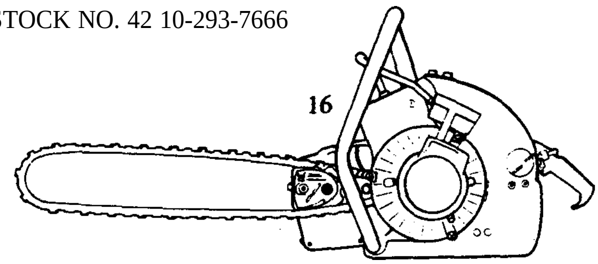
(13) The most likely time for a fire to start is during engine starting because of the excessively rich fuel mixture settings. The fire can best be extinguished by the pilot turning off the fuel tank valves, moving the engine mixture controls to "idle cutoff", and allowing the engine to run itself out of fuel.

(14) *Some* reciprocating engine-driven aircraft have spring-loaded fire extinguisher access doors on the lower outside portion of the engine



FEDERAL STOCK NO. 42 10-293-7666





ITEM NO.	QUANTITY	DESCRIPTION	FEDERAL STOCK NO.
	1	METAL CUTTING SAW	G5110-221-0235
2	2	SCREW DRIVER, COMMON, 4-INCH	G5120-227-9491
3	2	SCREW DRIVER, COMMON, 8-INCH	G5120-277-9494
4	2	SCREW DRIVER, PHILLIPS, 4-INCH	G5120-236-2133
5	2	SCREW DRIVER, PHILLIPS, 8-INCH	G5120-236-21287
6	1	PLIERS, LINESMAN	G5120-239-825
7	1	CABLE CUTTER	R5110-224-7053-5231
8	6	HACK SAW BLADES	G5110-142-4928
9	1	HACK SAW FRAME	G51 lo-2234971
10	1	"V" BLADE RESCUE KNIFE	RN51 10-524-6924
11	1	AXE	
12	1	DZUS WRENCH	
13	3	WOOD PEGS (SOFT)	
14	3	RUBBER PEGS	
15	1	GRAPNEL HOOK AND STEEL CABLE	
16	1	CHAIN SAW	

Figure 5-5. Crash rescue tool kit, chain saw, and grapnel hook.

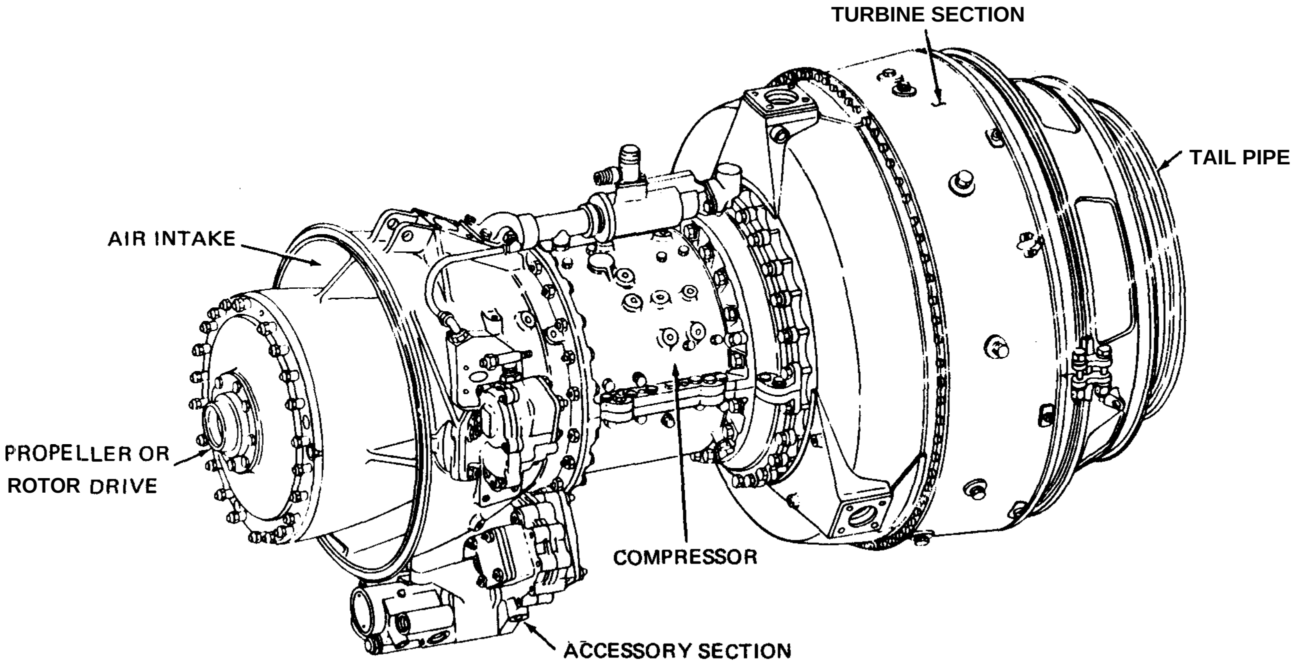


Figure 5-6. Gas turbine engine.

nacelles. These doors permit a fire extinguisher nozzle to be thrust directly into the accessory section of the engine. The doors are usually well labeled.

b. *Gas Turbine Engines.*

(1) A typical gas turbine engine (fig. 5-6) consists of an air intake, compressor, combustion section, turbine section, exhaust tailpipe, accessory section, and propeller or rotor drive.

(2) Short circuits in the electrical system or broken fuel and oil lines are major sources of fire. A firefighter will be prepared to immediately combat any electrical, oil, or fuel fire that occurs during ground operation of the aircraft or in the event of a crash.

(3) The firefighter will be on the alert for the possibility of an engine fire during starting and stolping of the gas turbine engine. If the engine is not started correctly, there is a tendency for fuel to drain or be pumped through the engine into the tailpipe or out the manifold drain onto the ground. A fire may start in the burned or turbine section after the throttle is closed. Should a fire occur, it can be extinguished by shooting CO_2 or CF3Br through the air intake duct or between the exhaust tailpipe and cowling.

NOTE

DO NOT DISCHARGE CO_2 DIRECTLY INTO THE ENGINE EXHAUST BECAUSE IT MAY DAMAGE THE ENGINE.

(4) The gas turbine engine is separated into four sections which are potential fire zones: the inlet compressor, combustor (including the tailpipe), and the accessory section. When combating gas turbine engine fires, the firefighter should attempt to separate hot engine parts or other sources of ignition from fuel sources and the primary structure of the aircraft.

(5) Although very improbable, explosive mixtures may form in the accessory section from fuel leakage. Sparks from the generator or starter motor will supply the remaining element needed for an explosion or fire within the accessory section.

(6) The engine is separated from the aircraft by a shroud which is similar to a firewall. The shroud is pierced by necessary openings for cables, linkage, tubing, etc. The shroud is installed so that it seals at the forward bulkhead, at the forward end, and is vapor-tight throughout its length. It, is highly improbable that the shroud will remain completely vapor- and liquid-tight after several removals and reinstallations during engine changes. The area surrounding an improperly sealed shroud becomes a hazardous area, in that there are generally many small pockets created by the stringers, ribs, and bulkheads of the nacelle in which fuels may collect and fill the zone

COLOR COOES

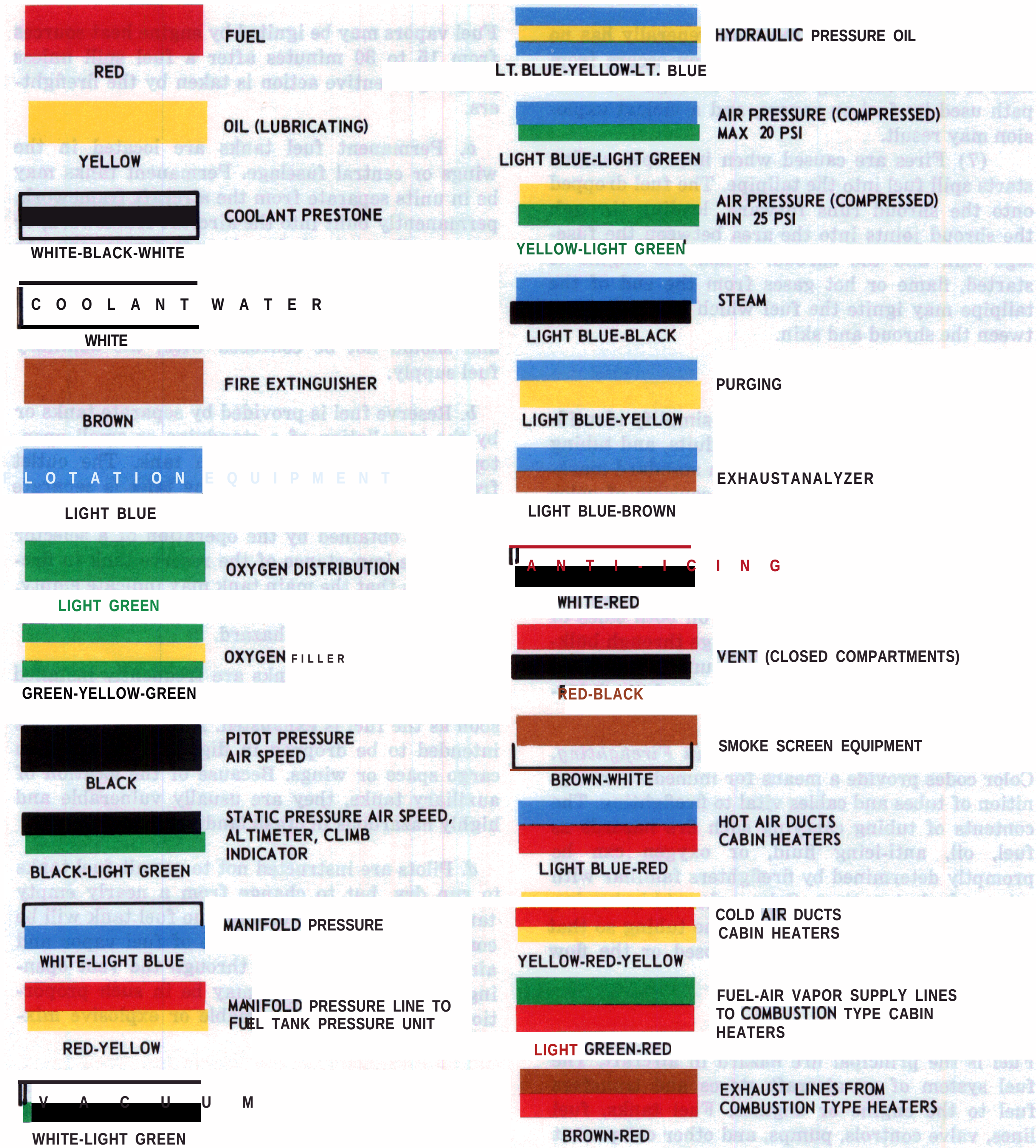


Figure 5–7. Identification colors for aircraft tubing.

with flammable vapor. The zone generally has no ignition sources of its own. Ignition occurs from heat or flame entering the zone through the same path used by fuel or vapors, and a violent explosion may result.

(7) Fires are caused when improper engine starts spill fuel into the tailpipe. The fuel dropped onto the shroud runs forward, leading through the shroud joints into the area between the fuselage skin and the shroud. When the engine is started, flame or hot gases from the end of the tailpipe may ignite the fuel which has leaked between the shroud and skin.

5-8. Color Codes

a. Identification of Tubing. To simplify identification and tracing of cables, conduits, and tubing of approximately the same size, a standard marking system has been devised. It consists of color bands in various combinations, each color combination indicating a specific type of equipment. The color code system used for tubing on all aircraft is shown in figure 6-7. Colored bands are applied to the tubing and cables on both sides of all points of connection and passage through bulkheads or sheaths. Where long runs of unjoined tubing occur, there may be color bands at intermediate points for identification.

b. Significance of Color Codes in F&refighting. Color codes provide a means for immediaterecognition of tubes and cables vital to firefighting. The contents of tubing carrying such fire hazards as fuel, oil, anti-icing fluid, or oxygen can be promptly determined by firefighters familiar with color code designations. Color codes aid in tracing sources of leaks or ruptures in the tubing so that either a cutoff valve may be closed or the flow may be stopped by other means.

5-9. Fuel System

Fuel is the principal fire hazard in aircraft. The fuel system of an aircraft stores and transfers fuel to the engine or engines. Fuel tanks, fuel lines, valve controls, pumps, and other component parts of the fuel system are widely dispersed throughout the structure of an aircraft. An outlet for escape of vapor or fuel may be produced by impact, twist, or movement of the aircraft or by improper assembly or maintenance. Ruptures in the fuel system are hazardous because of the existence of possible sources of ignition, suchas overheated metal surfaces, exhaust gases, electrical connections, discharge of static electricity, etc. Fuel vapors may be ignited by engine heat sources from 15 to 30 minutes after a fuel spill unless proper preventive action is taken by the firefighters.

a. Permanent fuel tanks are located in the wings or central fuselage. Permanent tanks may be in units separate from the aircraft framework, permanently built into the aircraft framework, or structurally part of the aircraft framework. As part of the permanent tank installations, a reserve supply of fuel is usually provided for emergency use. The reserve supply is separate from, and should not be confused with, the auxiliary fuel supply.

b. Reserve fuel is provided by separate tanks or by the installation of a standpipe or small open-topped tank within the main tank. The outlet from the reserve section of the tank is separate from the main tank outlet. Fuel from the reserve section is obtained by the operation of a selector valve. The importance of the reserve tank in firefighting is that the main tank may indicate empty, yet within the same tank the reserve section may be full, creating a fire hazard.

c. Auxiliary fuel tanks are frequently installed so that they can be dropped from an aircraft as soon as the fuel is exhausted. Auxiliary tanks not intended to be dropped in flight are installed in cargo space or wings. Because of the location of auxiliary tanks, they are usually vulnerable and highly hazardous in crash landings.

d. Pilots are instructed not to permit fuel tanks to run dry, but to change from a nearly empty tank to a full tank. Normally, no fuel tank will be completely drained. A mixture of fuel vapor and air, drawn into the tank through the vent opening, will be present and may be in such proportions as to create a flammable or explosive mixture.

e. Connections between fuel tanks of a multitank system are by direct openings in the tank walls or by tubing connecting the separate outlets. Fuel supply lines do not go directly from tank to engine, but pass through the wing or fuselage, or both, to control or selector valves at or near the pilots position. From the control or selector valves, the fuel lines go to the engine or engines. Tubing for venting and overflow extends from the tank interior to an outboard discharge point. The location of these outlets may be detected byopen-end tubing extending just beyond the exterior